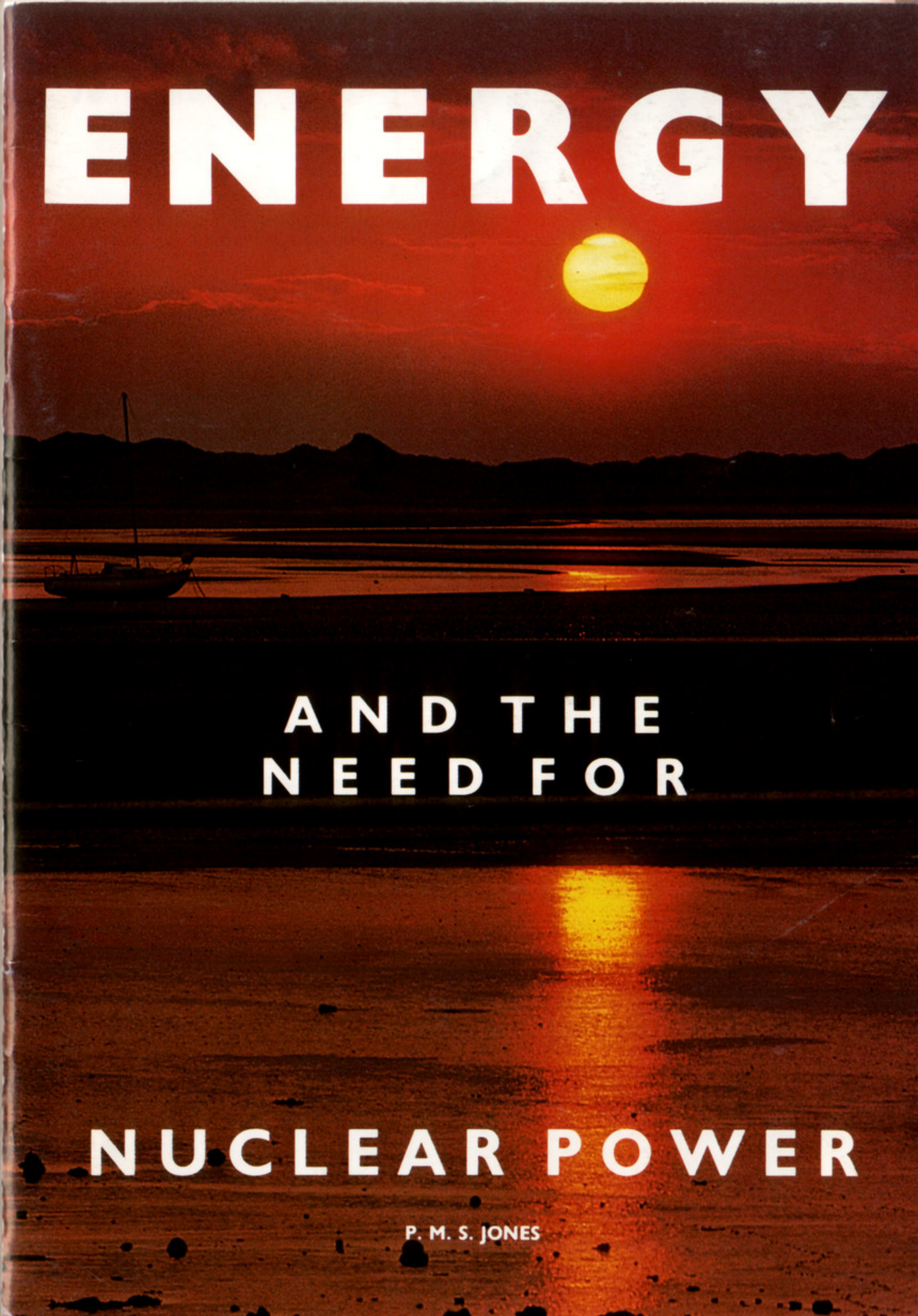


ENERGY

AND THE NEED FOR

NUCLEAR POWER

P. M. S. JONES

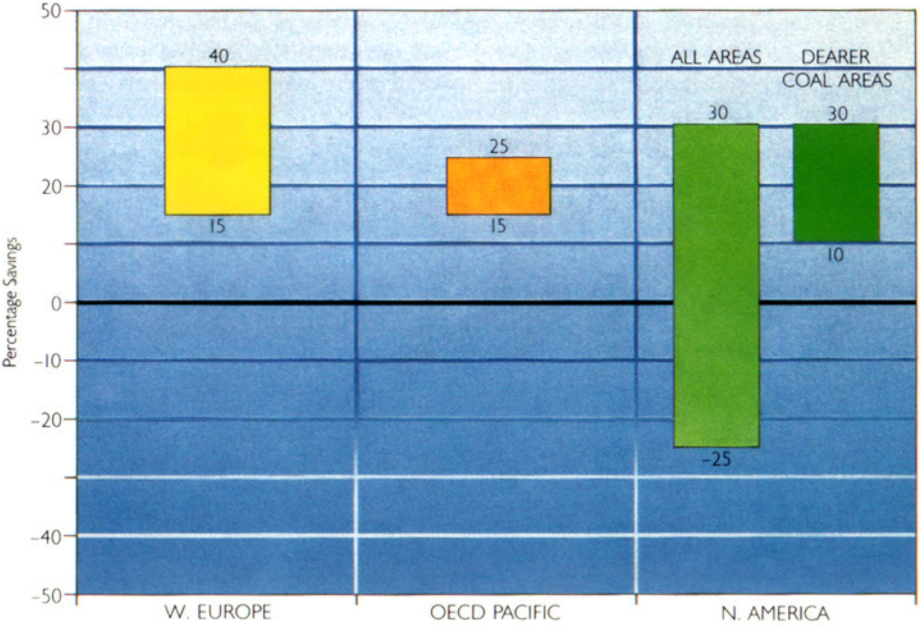
Nuclear power is not new. Electricity from Britain's first nuclear power station at Calder Hall was fed into the national grid over thirty years ago, and since then nuclear power stations have come to produce about a fifth of all electricity generated in the UK. Worldwide at the end of 1986 there were nearly 400 nuclear reactors producing electricity in 26 countries. Another 140 were under construction and a further 110 planned. By 1990 almost a quarter of the electricity produced in the non-communist industrialised countries will come from nuclear energy.

Calder Hall

The two main incentives behind this growing nuclear contribution have been lower costs and fears about the long term availability of fossil fuels.

After an initial period of development during which electricity from nuclear reactors was likely to be dearer than that from coal or oil fired power stations, nuclear was expected to become significantly cheaper than either. In a large part of the industrial world this expectation has been realised (Figure 1).

Figure 1: Savings from new nuclear stations (Percentage lifetime saving over a coal station).



Fears about shortages of coal, oil and natural gas are less pressing now than they seemed thirty years ago. This is due to the drastic reduction in world economic growth that followed the trade boom of the late 1960s and the first oil crisis of 1973. Other factors have been the discovery of sizeable additional quantities of oil, gas and coal and the reduction in energy demand, particularly for oil, that followed sharp rises in fuel prices during the 1970s. Nevertheless many countries do not have reserves of these fossil fuels within their own territory and for them fears of shortages arising from political actions beyond their control remain very real.

The UK is not one of these countries. It is well endowed with sources of energy, with its own oil and gas as well as reserves of coal that will last several hundred years at present rates of consumption. Indeed, the UK is fortunate at present in being among the few major industrialised countries able to produce more energy than it consumes. Against this background it is not surprising that many people ask whether the UK needs nuclear power.

Even on a world wide scale there is not an obvious shortage of other sources of energy. Oil is in plentiful supply again and the days of high oil prices seem, at least for the moment, a thing of the past. There are large reserves of coal in many parts of the world; there is more natural gas than was thought a few years ago; and there are the renewable energy sources, the wind, waves, tides and sunlight, the energy from which remains largely untapped.

Why then do we need nuclear power? To understand why many of us believe that nuclear energy will be an essential part of the world's and the UK's future supplies we need to look at how energy affects our lives and how changing lifestyles will affect the demand for energy. We need to explore what this means for future energy requirements and the resources that may be available to meet them. Finally we have to ask whether the UK's particularly favoured position places us in a different situation to that of the majority of the other industrial nations.

ENERGY

What is it?

We know what energy can do and we use it all day and every day of our lives, but it is not something we can catch hold of. It is what is used every time any change occurs in the world around us. It is needed to lift or move; to cut, drill, mould, bend or otherwise shape materials; to heat or cool; to melt, boil, bake or dry; to produce chemicals, fertilisers or plastics; to mine and quarry; to travel and transport; to plough and pump; to spin, weave and sew; to provide light and to operate electronic equipment.

Energy can be released by burning coal, oil, gas and wood. It can be extracted from wind, waves, tides and rivers. It can be changed from one form to another. Thus the heat from burning oil can be converted to steam pressure in a boiler; the pressure can drive a turbine to produce electricity; the electricity can be converted back to heat in a cooker, electric fire or furnace or into light for our homes or mechanical motion to drive tools or industrial machinery. Sunlight can be used to produce heat or electricity and wind or wave-power can be used to drive machinery. (Figure 2).

While energy can be released, extracted, used or converted it can not be created or destroyed. When we use it, some may be changed to other forms of useful energy. The remainder is spread out and lost as waste energy which is of no further practical value. Most ends up as low grade heat – a car engine gets energy by burning petrol and converts this to motion but all the energy is finally lost in the form of small temperature rises to the air around the car and to the road surface.

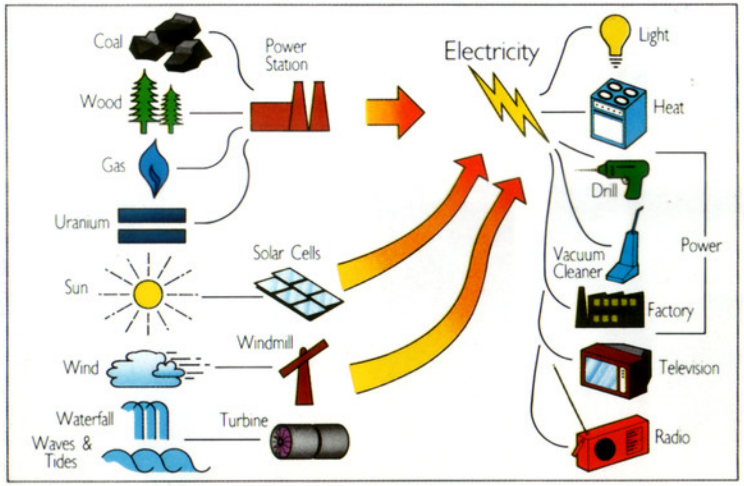


Figure 2.

Whether we are subsistence farmers struggling for our living in a poor country or wealthy citizens of an advanced industrial society our homes and all the goods we own, our food, drink and clothing, our work and our travel all require the use of energy, though the source of that energy and the amounts used will be very different in the two societies.

Patterns of Energy Use – The Developing World

Figure 3: World population and energy consumption.

Three quarters of the world's population live in developing countries. They consume barely a quarter of the world's energy (Figure 3). For large numbers of people living standards are extremely low. They have barely enough food for survival, few possessions and are very vulnerable to the natural disasters of drought and disease. Production of food often still depends on human muscle power or, for the lucky few, on animal power. Two billion people, nearly a quarter of the world's population, have no access to electricity. For many, firewood is the most vital source of energy but it is being consumed at an alarming rate, leading to increasing destruction of woodland and loss of farmland through soil erosion in several parts of the world. More effort then goes to the search for fuel, living standards worsen and the deserts expand their grip on the planet. On average, each person in the developing countries consumes only a sixth of the energy of a person in Western Europe or Japan, and only a fifteenth of a person in the USA (Figure 4).

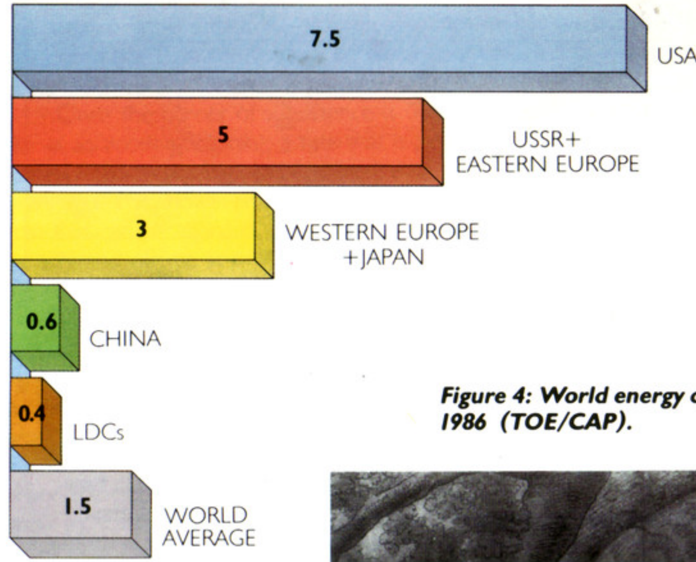


Figure 4: World energy consumption 1986 (TOE/CAP).

Figure 5: "Living in mud huts with only one room for sleeping, cooking and living... different ages and sexes herding together. Their cottages have no windows, but a hole through a mud wall to admit air and light, into which a bundle of rags or turf is thrust at night to stop it up". (Cobden).

The loss of forests is not new. It contributed to changes in lifestyle and in relative strength of nations in the Middle-East thousands of years ago. In Britain in the fourteenth century the destruction of woods and forests to feed industrial furnaces and meet domestic needs, as well as to provide a major material for construction, left the cottager with "a cold hearth and a bread and cheese diet and sorely restricted the output of manufactures".

Access to energy and the living standards of the peasant population of Britain were not so very different 300 years ago to that prevailing in much of the undeveloped world today. The average man was a servant working long hours for small reward, with few possessions other than his clothes and a few pieces of furniture. Although some use was made

Figure 6: Human energy consumption throughout history.

Daily Per Capita Consumption (1,000 kilocalories)

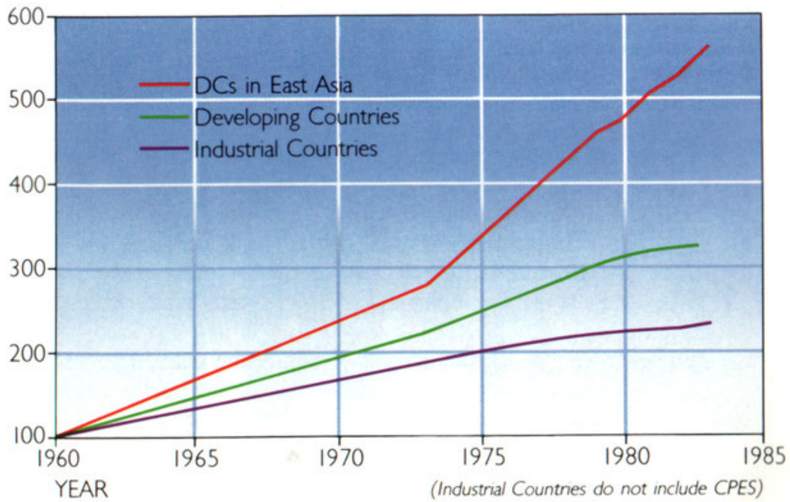
	Food	Residential and commercial	Industry and Agriculture	Transportation	Total
Primitive man	2	—	—	—	2
Hunting man	3	2	—	—	5
Primitive agricultural man	4	4	4	—	12
Advanced agricultural man	6	12	7	1	26
Industrial man	7	32	24	14	77
Technological man	10	66	91	63	230

Source: Data taken from Earl Cook, "The Flow of Energy in an Industrial Society," Scientific American, September, 1971.

of wind and water power and metal and pottery industries were in existence using charcoal or coal fuels, the production and inland distribution of food and goods were dependent almost entirely on either human or animal muscle power, and this had held back economic growth for centuries. With the invention of the steam engine in the eighteenth century great increases in production were made possible, and with them in living standards (Figure 6). The modern Briton works fewer hours, travels afar, has his own transport and entertainment systems, and a wide range of machines to do his work. He can afford to buy food and goods brought from all parts of the world.

It is an escapable fact that we can only enjoy the material benefits arising from the goods we are able to produce for ourselves (or that we have inherited from previous generations), or those arising from the goods we can obtain by trading our own products or services. The amount we can produce is limited by the energy we have at our disposal and the level of our technology. The energy we can have is itself limited by the share of our effort that we can afford to devote to producing it, or the amount that we can get in exchange for our surplus produce. The very poor countries are caught in a trap with no surplus

Figure 7: Growth of GDP index in various economies (1960=100).



and survival alone is their major challenge. Only when we are able to produce more than we need to consume can we begin to invest in plant, machinery, roads and transport.

Once the barrier of subsistence is overcome, living standards can rise at an accelerating rate; a rate that is far higher now with the accumulated technology and knowledge we have gained, than it was 200 years ago. This, however, requires that energy is available in quantity at a cost that can be afforded. The high rates of economic growth that can be achieved can be seen in the recent past in South-East Asia where they have taken full advantage of modern technology (Figure 7).

The less developed an economy the more its growth depends on access to energy using activities; energy to make and use fertilisers and agricultural machinery to raise crop yields; transport and construction to move, store and process produce; machinery and buildings for new wealth creating industries. Their, often rapidly, growing populations will add to their energy requirements – even to maintain existing living standards – and the population of the developing countries as a group could well grow by some 60% by 2020. As a result the energy demands of the developing countries, as a group, are expected to grow sharply, perhaps trebling by 2020 and accounting for nearly 40% of the world's total consumption by that date.

The Developed World

The developed world is very different. It already makes wide use of energy in all aspects of its activities. The average Briton (Frenchman, German or Japanese) and his family use energy at a rate that his or her seventeenth century forbears would find incredible.

Although in the richest industrial countries a large majority of households already have a car, a cooker, television, a washing machine, a refrigerator, and a number of the other domestic appliances considered essential to modern living, there are still many that do not (Figure 8). Clearly there is a limit to the number of appliances and tools a household can use, and a limit to the heating (or cooling/air-conditioning) and transport it requires. Nevertheless, there are benefits for many from having the extra freedom of more than one car in the family and even a

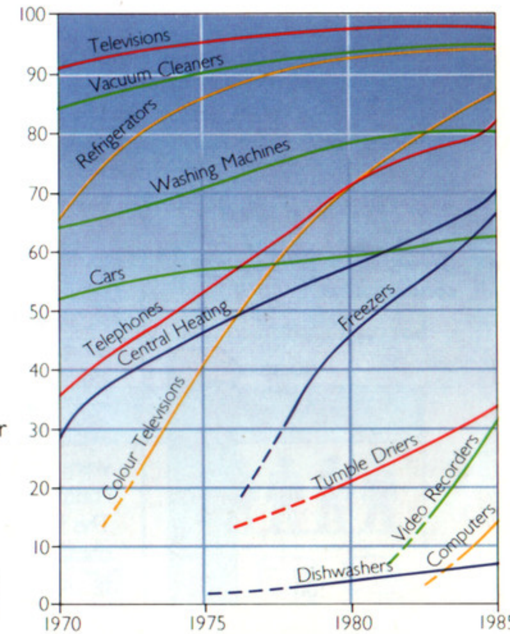


Figure 8: Ownership of consumer durables in the UK (% of total households).

second holiday home when it can be afforded. There is little sign that overall demand has reached the final level where everyone's wants are fully satisfied, and this means more goods will be demanded.

However, the energy needs of the industrialised countries, such as our own, the USA and Japan, may well not grow as fast in the future as in the past. Energy will be used more efficiently – buildings will be better insulated, cars more fuel-efficient, production processes more modern. Growth in their economies will ultimately depend less on industries that are heavy consumers of energy, such as iron and steel, and chemicals production, and more on newer industries such as electronics and computer manufacture, and on service activities. Even so it is difficult to see how economic growth over the long term could be achieved without continuing growth in their energy demand.

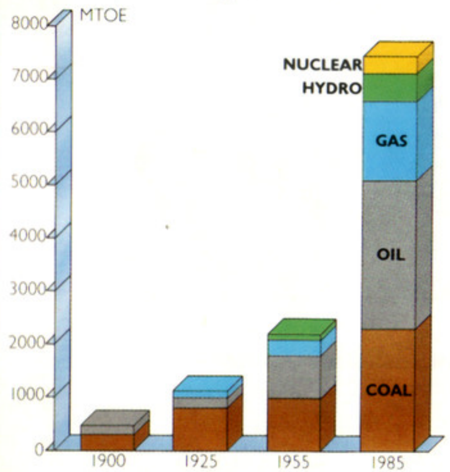
Even if the economic emphasis in the older industrial nations shifts away from energy hungry industries, they will still need to use steel, glass, concrete and chemicals and they will have to get these from the nations prepared to produce them, so that at least as much energy may be used, although in different countries.

The picture then is of a continuing increase in the world demand for energy, even allowing for the greater energy efficiency and other factors that will help to limit growth of demand in the industrialised countries.How will these energy demands be met?

How much energy will we need?

Energy consumption worldwide has grown some twenty-fold since 1850 whilst the world's population has grown only four-fold. Since 1955, when the first nuclear power stations were built, consumption has trebled. The initial growth was mainly satisfied by expanding coal supplies, but the last fifty years has seen an enormous increase in the use of oil and natural gas (Figure 9).

Figure 9: Growth in World energy consumption.



During the 1950s and 1960s these fuels, particularly oil, were plentiful and cheap and their abundance and cheapness was one major factor in the unprecedented rates of growth achieved in the booming economies of the industrial nations.

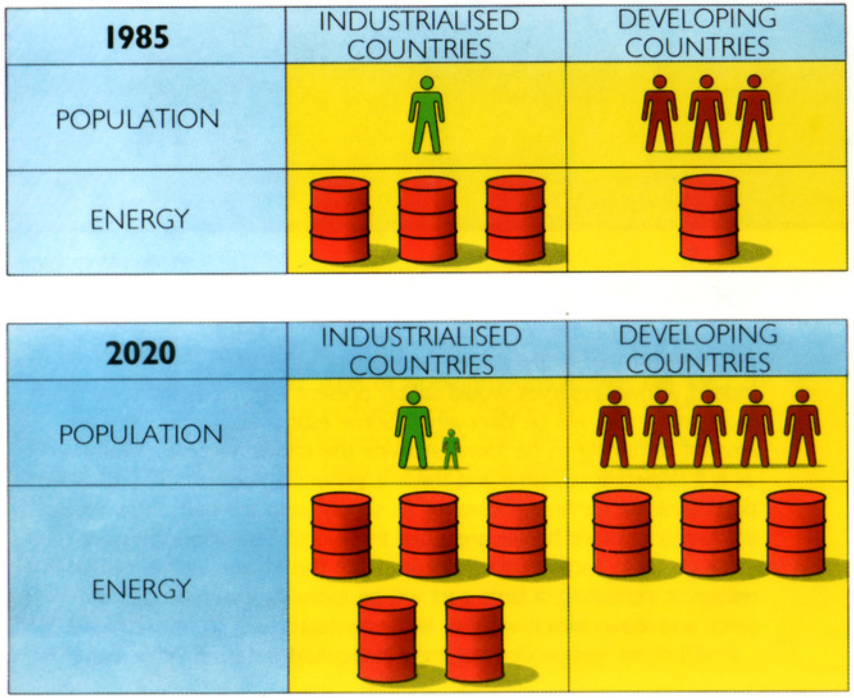
The oil supply crises of 1973 and 1979–80 and the accompanying major price rises, which were reflected in other fuels too, have contributed to a prolonged world recession. This has held down the growth in energy demand and concentrated attention on the more efficient use of energy.

There are some very different views about how energy demand may change in the future. Some believe that the days of high economic growth will never return; that still more efficient use of energy will reduce requirements; and that the citizens of the developed industrial nations are close to having all the goods and energy using appliances they need. If this were to prove true the increases in energy demand in the industrial countries over the next 50 years could be quite small compared with the last 50.

Others believe that high economic growth will return provided there is a plentiful supply of cheap energy and essential raw materials. The efficiency of energy use might then increase even more quickly as new technologies take over. However, energy would be used for new purposes and there need be no flattening-off in the improvement in living standards. Without such a development it is hard to see how full employment can return in the industrial countries. If this view were to prove true, then energy demand in the industrial nations might double or even treble again in the next 30 years.

As we have seen, the developing countries will need to increase their energy use substantially to keep pace with population growth. If they are to *improve* their living standards significantly, a four or even five-fold increase would be needed. This would still leave them in 2020

Figure 10: Growth in population and energy demand 1985–2020.



with less than one-half the energy per head of population in the industrialised countries.

Again views differ on what is likely to be achieved. Some countries' economies may break out of the subsistence trap, others will not. Some are already well on the path of upward growth, others are deeply in debt, still others are experiencing famine.

There is no way of knowing what the future will be. It will lie probably somewhere between the extremes, perhaps with world demand roughly doubling by 2020. Whatever the outcome, two things are clear:
- Energy demand in 2020 will be higher than it is now.
- Energy supply must be able to meet the demand at a reasonable cost if it is not to be a constraint on economic growth.

Where will our energy come from?

Nearly 60% of the world's energy today is met from *oil* and *natural gas.*

Oil

There is still a large amount of oil available to be recovered. Indeed, *known* reserves would supply present day needs for some 35 years, and more will be discovered. Some estimates put the ultimate amount remaining to be found at twice the known reserves. However, oil is a depleting resource and there is general agreement that it will not be possible to continue increasing its supply as in the past. New finds are largely in more hostile areas like the North Sea where they are more costly to recover than supplies from the Middle East. Of the resources remaining, a large part will be extra-heavy crude oils, tar sands and shales which will also be costly to convert to usable products.

Demand and production grew three-fold between 1950 and 1979 but there has since been a 10% drop in consumption. This is because there has been a deliberate switch to other fuels in many applications, including to nuclear power for electricity generation. The switch is a reaction to high prices and uncertainty about future supplies. However, for many users there is no ready alternative to oil – for example, in road and air transport. Oil is also hard to replace in some uses where its ease of handling gives it a special advantage or where it would be difficult and costly to use other fuels. There is likely to be a continuing growth in demand in these markets although there is room for further savings in the use of oil for heating and electricity production in the developed nations.

Any upsurge in demand could lead rapidly to rising prices which would renew pressures to conserve oil for essential uses. Prices could also become vulnerable again to supply disruptions. Although the Middle East now accounts for barely 20% of world production, over half the world's known oil reserves lie in that region (Figure 11). The Middle East's political instability could therefore affect both the availability and price of supplies in the longer term as reserves in other parts of the world are used up.

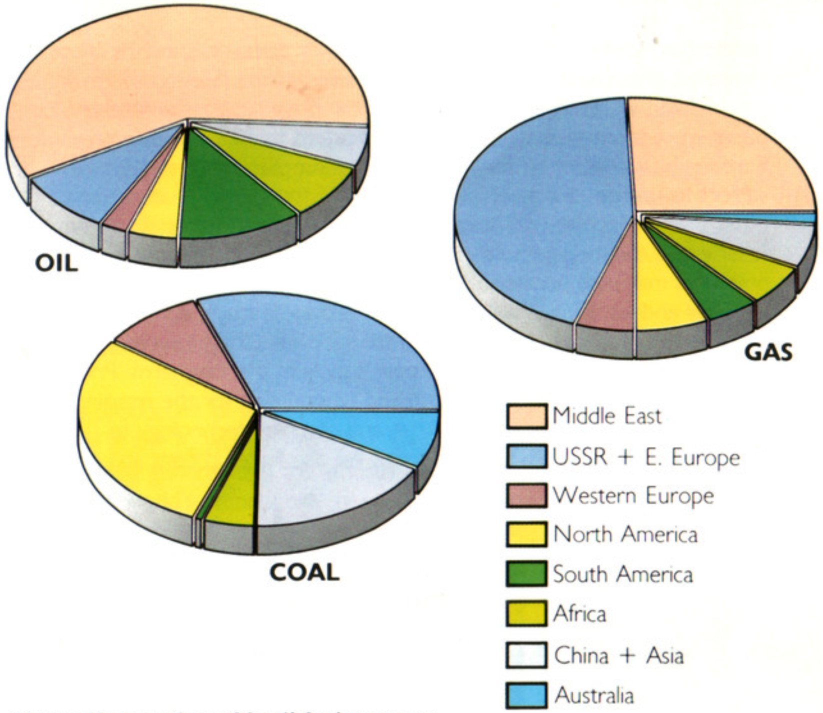


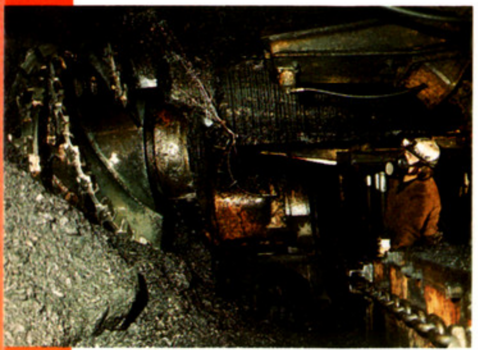
Figure 11: Location of fossil fuel reserves.

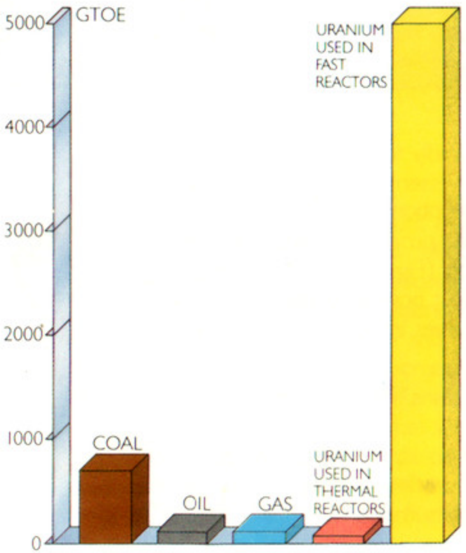
Natural Gas

Proven reserves of natural gas are a little smaller in energy terms than those of oil, but at present rates of consumption they will last until almost the middle of the next century. Further discoveries will be made. However, about 40% of existing reserves lie in the USSR and 25% in the Middle East. Long distance pipelines will bring supplies to Western Europe but there must be a limit to the extent to which Western Europe will want to become dependent on supplies which might be subject to sudden disruption. The difficulty of transporting natural gas other than by pipeline will limit the rest of the world's access to these reserves. In the long term, conversion to liquid fuels or shipment at high pressures may ease access to supplies, but at higher costs.

Oil and natural gas will continue to provide a major contribution to world energy supplies until well into the next century. However, there is little scope for greatly increasing their supply in the long term. Prices will rise as the reserves are used up and competition for the remainder intensifies. The need for more difficult and complex technology to recover and convert them to useful forms will also force up costs and prices.

Coal





Proven world reserves of coal are large, over three times those of oil and natural gas together (Figure 12). Consumption worldwide increased by about a third in the 10 years up to 1985 as countries turned away from oil, mainly by switching to coal for

Figure 12: World fuel reserves.

electricity generation and as a source of bulk heat in industry. In the more distant future coal will be required increasingly for conversion to a liquid fuel and to substitute natural gas (SNG), and as a source of chemicals. However, while reserves of coal are large, not all of these will be cheap to exploit and bring to their markets. Coal is likely to become dearer in the longer term as demand grows and more difficult and expensive resources have to be mined. This will make it an increasingly expensive option particularly if it alone were to be relied on to meet growing world energy requirements.

Nuclear Power

World production of nuclear power is growing fast – it increased four-fold in the 10 years up to 1986, and now provides around a fifth of the electricity generated in the industrialised countries, and meets about 5% of the world's primary energy consumption. In 1985 it produced energy equivalent to 340 million tonnes of oil or some 500 million tonnes of coal. Figure 13 shows the contribution being made in various countries.

Uranium provides the fuel used in nuclear reactors. Used in the type of nuclear reactors now in operation, the world's known resource base of uranium is about the same in energy content as that of proven oil reserves (Figure 12). Ultimate low cost resources of uranium may be some two to four times larger. They are therefore large but do not compare with coal so long as uranium use is largely limited to existing commercial nuclear reactors.

These reactors, the so called thermal reactors, are able to use only a small fraction of the energy available in uranium. However, in the next generation of reactor, the 'fast' reactor, virtually all the energy in the uranium can be used, thus increasing the energy recoverable from the world's uranium reserves some sixty-fold. Moreover, since the cost of extracting uranium is an insignificant part of the cost of the electricity generated in a fast reactor, the uranium resource can be extended to include the large amount of uranium that would otherwise be uneconomic to exploit, possibly even to the vast amounts which occur in very low concentration in sea water. Under such circumstances uranium could contribute in the long term very much more to energy than all the fossil fuels put together.

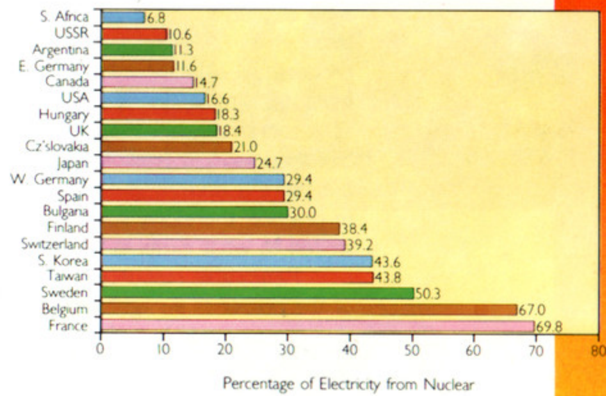


Figure 13: The twenty countries with the highest Nuclear shares of generation in 1986.

To illustrate the enormous energy content of uranium we can note that the UK alone already has stocks of depleted uranium (25,000 tonnes) that, if used through a fast reactor, would provide the energy equivalent of all the UK's economically recoverable coal resources (about 45,000 million tonnes).

Fast reactors have attractive safety features and their technology is already proven. Indeed, the UK first generated electricity from a fast reactor in 1959. Large fast reactors are operating in France, the USSR and the UK. What remains is to demonstrate the performance of the reactors and their fuel plant at a full commercial scale.

Current thinking is that fast reactors will become the cheapest source of base-load electric power. When this will happen depends on the rate of development of reactor design and the future price of uranium and nuclear fuel cycle services. The United Kingdom Atomic Energy Authority believes that electricity from a series of commercial size fast reactors served by commercial size fuel plants could be comparable in cost to that from existing thermal reactors, even at current nuclear fuel prices. These fast reactors might be coming into operation in the second decade of the next century by which time increases in uranium prices might make them even more attractive.

Renewables

The quantity of uranium was fixed when the earth was formed although its concentration in particular ores was due to later geological processes. Coal, oil and natural gas resources were formed long ago from decaying biological materials and their replacement, if it occurs at all, is extremely slow. Some natural gas (methane) is formed from non-biological sources (radioactive decay of minerals in the earth's interior) but there is no evidence that such gas accumulates in usable quantities. In practice, therefore, supplies of both uranium and fossil fuels are limited to what exists in the earth's crust (and oceans for uranium).

Renewable resources have no such limitation. They take advantage of the power of sunlight and the effects of gravity which between them give rise to a number of energy sources which replenish themselves continuously.

Hydroelectricity is generated from flowing rivers, using dams and reservoirs for all but the smallest schemes. It is an established renewable energy source that has been exploited for many years. It currently provides 7% of the world's energy, and there is some scope for increasing its contribution in many parts of the world. When available it can often provide very cheap electricity.

A great deal of research has been carried out in recent years into other ways of harnessing renewable energy, by using the winds, waves and tides to generate electricity, or by using the sun's rays directly to provide heat or electricity, or through vegetation (biomass) to provide new fuels. This research has shown that some of these methods are attractive and can provide energy at costs which compete with those of





other fuels. Indeed, some of the technologies are already being used – for example electricity is being generated in small amounts using the wind and the tides and, in special situations, using sunlight. In some countries the earth's own internal heat is being exploited. However, research has also shown that there are limitations to the size of contribution that may be expected from the renewable energy sources even though the resources themselves may be large.

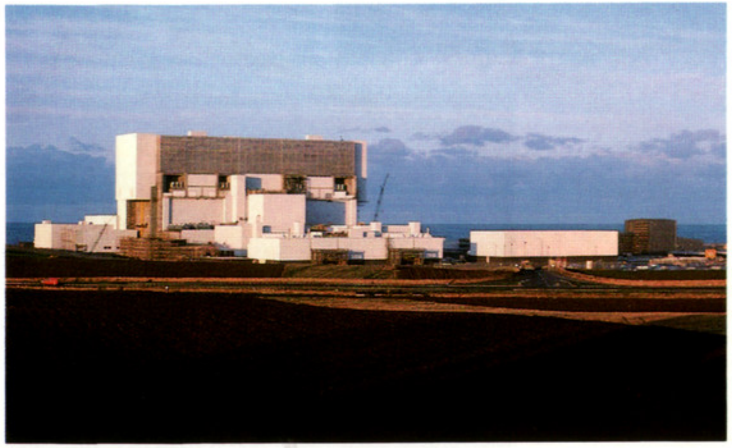
These limitations come about because:

(a) renewable energy is generally spread over wide areas and the technology required to capture and concentrate it is expensive in relation to the energy obtained;

(b) the energy is not always available when needed; rivers can dry up and biomass crops can fail in periods of drought; the wind does not always blow; in Northern Europe the greatest amount of solar radiation occurs in the summer, but the need for space heating is greater in winter;

(c) it can take a long time for new technologies to come into widespread use; one of the most attractive ways of using renewable energy in countries such as the UK is by designing buildings so that they capture and retain the sun's heat, but this can only come about as existing buildings are demolished and replaced.

Renewable sources will be important and economic in some applications. They can be expected to meet a growing proportion of the world's energy needs in the future, but it is difficult to see how this can be more than a small proportion over the next 40–50 years. Their biggest potential share is in the developing world where local energy demand may not justify large energy schemes and some renewable sources are abundant. However, cost will be all important and will limit what can be achieved.



THE CASE FOR NUCLEAR POWER

Energy supplies from both **Coal and Nuclear Power** could be increased considerably and both would be able to meet increased demand for centuries to come. With fast reactors nuclear power could last for thousands of years. Oil and natural gas will contribute significantly for well over 30 years at current rates of use but have no prospects for long term expansion. A doubling of world energy demand with oil and gas use held at present levels would need a three and a half fold increase from other sources – for example a trebling of coal supplies and quadrupling of nuclear or a doubling of coal and twelve fold increase in nuclear, or, with a 10% share from renewable energy, a doubling of coal and quadrupling of nuclear.

The price of all fossil fuels must increase as reserves are depleted and more difficult sources have to be brought into production. Nuclear electricity costs need not increase significantly above those now experienced because fuel costs are a smaller part of the total cost of its production, particularly in the fast reactor.

Some renewable sources, additional to those in use, have promise, but their contributon is generally expected to be limited by availability, scale and cost.

Only nuclear, therefore, offers the long term prospect of meeting the growth of world energy demand whilst keeping energy costs close to present levels.

At present nuclear power is used mainly to produce electricity but nuclear heat is used on a limited scale for district heating and manufacturing and this could be expanded in the future. Even so, nuclear could not become the dominant energy source for a very long time.

How will the benefits of nuclear power be felt?

There are four main ways in which benefits arise:

Fossil Fuel Savings. Generating electricity already accounts for 25% of the world's consumption of fossil fuels. Using nuclear energy to produce electricity reduces the need to burn these fuels, so that they will last longer. Whereas the uranium used to fuel nuclear reactors has no other uses, oil, gas and coal are current or potential feedstocks to the world's chemical industry. From them can come the plastics, synthetic drugs, dyes and many other products on which we rely heavily. Oil provides the only convenient and compact fuel for much of our transport and when it is depleted liquid fuels made from gas or coal will be needed increasingly. (Long term alternatives might be hydrogen, which would be produced from water using nuclear electricity, or, for road and rail vehicles, the direct use of electricity for propulsion).

Lower Prices. If less oil, gas and coal are used costs and prices will stay lower than they otherwise would be. This will benefit all of us, but it will be particularly important for the developing countries for whom the cost of importing fuel will be a continuing and increasing burden. While the richer countries will be able to afford higher fuel prices, the poorer, developing countries will find it much harder to do so. By conserving the world's fossil fuels, nuclear power can indirectly benefit the developing countries. The larger the nuclear share, the slower the rate of rise of fossil fuel prices will be.

Economic Activity. Higher energy costs mean that more effort is being put into getting energy and that less is therefore available to produce other goods and services. Nuclear power, by providing a lower cost energy source, releases resources which can be used by individuals or society as a whole to improve standards of living. The freed resources may be used to produce goods or for social purposes: examples include improved health care, education, roads, etc., sponsorship of the arts or investment in scientific and technological development; aid to the less well off within the country; aid to the developing world.

Environmental issues. Burning fossil fuels produces carbon dioxide. There is concern among meteorologists that increasing consumption of fossil fuels is leading to a build-up of carbon-dioxide in the earth's atmosphere; in time this could raise temperatures, much as the glass in a greenhouse increases the temperature of the air inside, and there could be harmful effects on climate. More research is needed to understand whether this concern is justified, but at this stage it would seem unwise to assume that the world will be able to continue indefinitely its consumption of fossil fuels. Nuclear power offers a way of meeting increasing production and is the only feasible way of replacing all fossil fuels if this were ever to be found necessary.

The other noxious emissions from coal burning, some of which contribute to the acid rain which many believe is harming lakes and forests in the industrial world, can be reduced, but at a cost. Oil burning in power plants, furnaces or road vehicles may also contribute to environmental damage. Use of nuclear power would eliminate the source of some of these problems both directly in electricity production and where nuclear electricity is substituted for fossil fuel, in heating for example.

Worries about nuclear power

People worry about the safety of nuclear power and the effects on the environment of having to deal with nuclear wastes. The nuclear industry is confident that both safety and wastes can be managed so that the risks to the public and the workforce are kept at levels at least as low as those from other industries. This view was endorsed by the inspector, Sir Frank Layfield, at the Sizewell Inquiry. It is outside the scope of this article to deal with the complex technical issues involved.

The choice for the UK

During the early 1980s the UK has been able to produce more energy of all types than it has needed for its own consumption. In the 1990s this will no longer be true as oil resources are depleted. Nevertheless, our coal could see us through for a long time provided we could afford to import oil for transport uses.

We have even had an excess of electricity production capacity due to economic growth and electricity demand in the 1970s failing to reach the levels that had been planned for. By the mid-1990s and into the next century new power stations will be needed, both to replace old and expensive-to-run ones that are reaching the ends of their lives and to meet the extra demand for electricity. New stations planned today should still be operating in 40–50 years time, so that current fuel prices are of little relevance to the decision on what types of station to build.

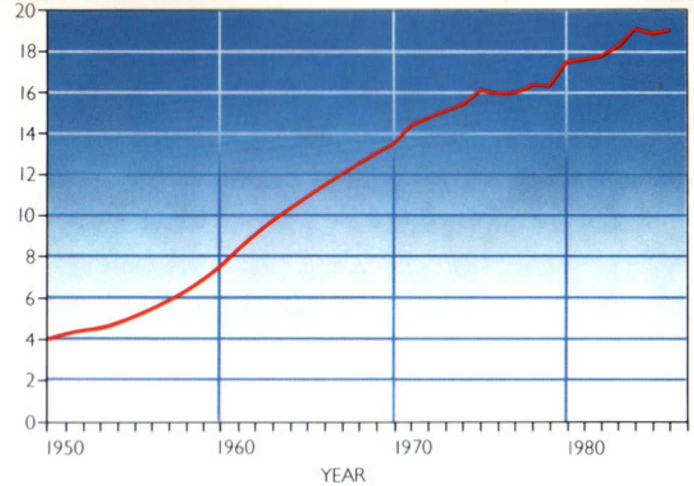
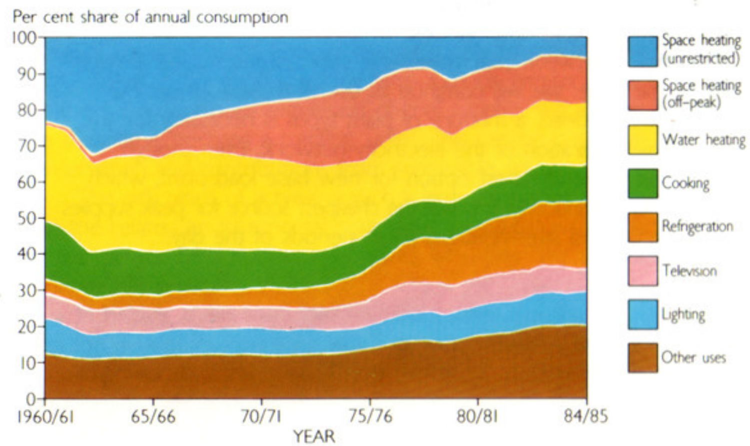


Figure 14: % of electricity in UK final energy use except transport.

If we exclude the transport sector, nearly a fifth of the energy used in the UK is supplied in the form of electricity, and demand for it is growing faster than the demand for energy in general (Figure 14). Figure 15 shows the many different ways in which electricity is now used. New developments often make electricity the cheapest way of meeting a need for energy, and energy saving measures, like insulation of buildings, can increase the demand for electricity for this reason, allowing it to substitute for coal, oil or gas.

The UK's nuclear power stations currently produce around one fifth of the country's electricity, and this proportion will rise to one quarter when the stations at present being commissioned or under construction are fully operational. Operating these stations saves the Generating Boards and hence the country some £500M a year in fuel and other operating costs, a saving that will increase to £1000M when the new stations are operational. £1000M is about the same as the amount of money spent each year on the hospital building programme.

Figure 15: Estimated component shares of domestic electricity consumption 1960/61 – 1984/85.



The choice facing the UK is whether to build nuclear or coal fired power stations. Some of the benefits of choosing nuclear are the same as those described earlier: fossil fuel savings, lower energy and fuel prices, higher standards of living; environmental insurance and reduced pollution.

☐ Coal saving itself may not appear to be of major value to a nation with large resources like the UK. However, coal saved will be available for other uses and for export, provided it is priced competitively. Supplies will be freed at a time when world demand and prices are likely to be rising.

☐ Even at current coal prices, nuclear electricity will be cheaper and lower electricity prices will leave the consumer better off. The effect of the competition should help to keep prices down and this too will benefit the consumer.

☐ The greater spending power of electricity consumers will help to stimulate sales of other goods and services and provide employment.

☐ Lower energy costs for industry will help to keep it competitive internationally.

☐ Nuclear power will help the UK to limit or reduce release of carbon dioxide, acid gases and other pollutants to the atmosphere.

Use of nuclear power in the UK should additionally:

☐ Provide diversity which will reduce risks of power supply shortages arising from interruption of any one fuel source. It will also reduce the consequences of any unforeseen price rises of fossil fuels.

☐ Provide growing direct employment in the nuclear industry and design and manufacturing experience which may lead to new export business in this area.

☐ Reduce the higher risks of accidents, disease and pollution associated with coal mining and use.

In the longer term, renewables like wind or geothermal hot rocks or tidal barrages may add to the contribution to electricity production already coming from hydropower in the UK. The total contribution looks likely to be limited to below one quarter of total supplies for technical, availability and cost reasons.

The choice between coal, renewable sources and nuclear power will not be exclusive: we will continue to use all three to meet our electricity needs. Indeed, a mixture of plant types is necessary for the most economic operation of the electricity network. Even though nuclear power is the cheapest option for new base load plant, which operates almost continuously, it is not the cheapest source for peak supplies which are demanded over relatively short periods of the day.

What can we conclude?

Energy demand will grow, fossil fuel prices will rise, and oil and gas will be unable to maintain their share in supplies very far into the future. There will be a growing need for extra energy which can only come from coal, nuclear or renewable sources, and probably from a mixture of all three.

A non-nuclear policy, apart from its damaging effects on the environment, would push energy prices up, render the economy vulnerable to disruption, make industry less competitive, reduce standards of living and run the risk of pushing unemployment higher.

Nuclear power is available, proven and has the greatest potential in resource terms. It is also among the cheapest options. Its use will be environmentally and economically beneficial.

It would be unrealistic, however, to expect nuclear to increase its share of the world total primary energy supply to much above a fifth by 2020, if that, although in the long term a much greater share could be achieved. An enormous expansion of coal supplies will also be needed in the meantime, perhaps a trebling, unless this can be cut down by conservation and contributions from renewable sources.

The difficulties of achieving such a large growth in the coal industry plus the related environmental risks argue for the rapid adoption of nuclear power (and nuclear heat plant) wherever this is technically and economically sensible.

In helping themselves the industrial nations like the UK will also help the developing countries which cannot benefit so readily from nuclear power, by freeing fossil fuels which can substitute directly for woodfuel in their economies.

About the author.

Professor Peter Jones is Chief Economic Adviser to the United Kingdom Atomic Energy Authority. He holds a Professorial Research Fellowship at the University of Surrey, is vice-chairman of the Nuclear Energy Agency's Fuel Cycle Committee and chairman of OECD/NEA expert groups on the economics of nuclear power and the nuclear fuel cycle.

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